SUNLIGHT AS A FACTOR INFLUENCING THE THICKNESS OF EPIDERMIS*

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The relationship of sunlight to skin cancer has been known since the days of Unna (1). Recently many studies have confirmed this observation (2–4) and have shown a striking correlation between the high incidence of skin cancer in geographical areas having much sunshine. In laboratory experiments, skin cancers have been produced in various animals by natural sunlight as well as artificial ultraviolet sources (4, 7, 8, 9), germicidal lamps (10), and fluorescent lamps in photosensitized animals (11). It has been concluded that the erythemogenic mid-ultraviolet wavelengths are the most important in producing neoplastic changes in the epidermal cells. Also, the relationship of sunlight to degenerative changes in dermal connective tissue has been demonstrated (5, 6). Many outdoor occupations involve prolonged and repeated sun exposure and this sunlight exposure has been related causally to premature aging of exposed skin (5, 6). It is interesting that cutaneous alterations described as being due to sunlight have been largely confined to the dermis, with only passing reference to the epidermal changes except for carcinogenesis. Lorincz (12) has pointed out that the major changes appear in the dermis rather than epidermis and skin appendages.

This report concerns an evaluation of the influence of race, sex, complexion, age, and sunlight exposure on the thickness of the epidermis and its component layers in a group of healthy persons.

METHODS

Skin biopsy specimens from 28 patients in three age groups were taken at the Texas State Department of Correction, Huntsville, Texas.

Biopsy specimens of skin were taken from each subject from three areas which could be reasonably assumed to have received varying amounts of sunlight exposure. The sites selected were: upper lateral quadrant of buttocks (an area receiving little or no exposure to sunlight); dorsal forearm two inches above the wrist (an area which might be exposed moderately or intermittently); and lateral malar area of the face (an area of maximal exposure). A rotary punch was used to take specimens which were 4 mm. in diameter from the face and 8 mm. in diameter from the forearms and buttocks. The wounds were then sutured with interrupted 4-0 black silk sutures.

The three age groups were: twelve young adults (25–33 years of age); twelve middle-aged persons (40–53 years of age); and four older patients (66–76 years of age). Volunteers were selected by the officials on the prison staff, and these individuals chose patients on a basis of age and sex only. They were completely unbiased in their selection of volunteers as to complexion, amount of sunlight exposure, or degenerative change of skin. Six patients were Negroes and twenty-two were Caucasian. Fifteen patients were males and thirteen were females. The white patients were classified into light, medium or dark complexion types on the basis of the color of eyes, hair and skin (covered and uncovered areas) plus a history from each patient as to the relative difficulty or ease with which they sunburned or tanned. There were eleven light, six medium and five dark complexioned white patients. The six Negro patients were also objectively classified as to degree of skin pigmentation, whether light, medium or dark.

The biopsy specimens were immediately fixed in 10% formalin and they were later embedded in paraffin and sectioned at 7 micron thickness in the routine manner. Hematoxylin and eosin stained sections were used to study epidermal changes. The thickness of the various layers of epidermis was measured with an ocular micrometer which was calibrated against a stage micrometer. These measurements were originally recorded in arbitrary units and later converted to microns. Each specimen of skin was measured at ten separate points approximately 100 microns apart. At each point three measurements were taken: (1) the thickness of the stratum corneum; (2) the minimum thickness of the viable layer; and (3) the maximum thickness of the viable layers. The latter two measurements included the basal, prickle, and granular cell layers and were delimited by the basement membrane and the junction of granular cell layer with stratum corneum. The minimum thickness represents the thickness of suprapapillary epidermis while the maximum

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thickness reflects the depth of the rete ridge. Each of these measurements was selected within ten microns from each point of measurement, avoiding any skin appendages present. Thus, at each of ten points, three measurements were made resulting in a total of thirty measurements for each specimen of skin. The ten figures for each dimension measured were averaged to give the final average figure recorded in Charts 1 through 5.

The measurements from the various groups were then compared to evaluate the following:

Negro vs. Caucasian Epidermis
Male vs. Female Epidermis
Young vs. Old Epidermis
Light vs. Dark Complexion
Mild vs. Severe damage

CHART 1

Thickness of epidermis: negro versus white epidermis

		Negro	White
Stratum corneum	Buttocks	30	27
	Arm	38	38
	Face	10	14
Minimum of viable layers	Buttocks	42	45
	Arm	45	45
	Face	50	48
Maximum of viable layers	Buttocks	115	105
	Arm	101	75
	Face	106	67

All measurements are average figures shown in microns.

CHART 2

Thickness of epidermis: male versus female epidermis

		Male	Female
Stratum corneum	Buttocks	23	31
	Arm	42	34
	Face	15	15
Minimum of viable layers	Buttocks	47	41
	Arm	44	46
	Face	47	48
Maximum of viable layers	Buttocks	110	92
	Arm	83	77
	Face	67	67

All measurements are average figures shown in microns.

CHART 3

Thickness of epidermis: young versus old epidermis

		Young	Old
Stratum Corneum	Buttocks	24	29
	Arm	36	40
	Face	13	12
Minimum of viable layers	Buttocks	46	45
	Arm	46	44
	Face	50	46
Maximum of viable layers	Buttocks	115	96
	Arm	76	75
	Face	68	65

All measurements are average figures shown in microns.

CHART 4

Thickness of epidermis: light versus dark complexion

		Light	Dark
Stratum corneum	Buttocks	26	28
	Arm	40	48
	Face	11	15
Minimum of viable layers	Buttocks	43	50
	Arm	47	44
	Face	45	47
Maximum of viable layers	Buttocks	102	110
	Arm	78	74
	Face	61	68

All measurements are average figures shown in microns.

CHART 5

Thickness of epidermis: mild versus severe damage

		Mild	Severe
Stratum corneum	Buttocks	24	28
	Arm	38	40
	Face	12	16
Minimum of viable layers	Buttocks	44	45
	Arm	47	42
	Face	49	46
Maximum of viable layers	Buttocks	113	95
	Arm	73	72
	Face	67	67

All measurements are average figures shown in microns.

The epidermal measurements, using the raw data, were analyzed on an I.B.M. 1620 computer by the determination of variants method to establish the statistical significance of these values. This analysis was performed by the Biostatistics Department of Baylor University College of Medicine.

RESULTS

In comparing the measurements of epidermal thickness of six Negro individuals with an equal number of white subjects of comparable age and sex, several interesting variations were observed (Chart 1). A consistent regional variation indicated the stratum corneum to be thinner on the face than on covered areas of the body. Although the stratum corneum of the face of Negroes was found to be consistently thinner than for whites, this difference was not significant at the 5% level.

The minimum thickness of the viable layers was remarkably uniform in all regions and in both races. In fact, throughout this entire study there was no apparent difference in this measurement for any of the group comparisons.

In measurements of the maximum thickness of viable layers in white individuals an interesting regional difference was apparent in that the buttocks (an unexposed area) was thicker than the arm or face (Chart 1). This difference was statistically highly significant at the 1% level and occurred in young adults as well as older persons. The comparable values for epidermis of Negroes, however, did not show this difference, there being no statistically significant regional difference in Negroes (Chart 1). Furthermore, there was a significant difference in these values for the arm and face between Negro and white subjects with values for white skin being reduced. This difference was significant at the 2% level. The unexposed buttocks skin revealed no differences between white and Negro.

Comparisons of twelve male and ten female white subjects of comparable age, complexion, and degree of actinic damage revealed no difference in thickness of epidermal layers in the two sexes (Chart 2). Regional differences were again apparent as in the previous chart. When eight young individuals 25 to 33 years of age were compared to nine persons 50 to 76 years of age the minor differences observed between the two age groups were not of statistical significance (Chart 3). The results were similar when persons of light and dark complexion were compared (Chart 4).

Eight subjects with mild or no actinic degeneration in the dermis were compared to a comparable group of seven persons having severe dermal actinic degeneration (Chart 5). These figures suggested that the stratum corneum might be slightly thicker in severely damaged skin; however, the difference was not statistically significant at the 5% level. There was a wider variation in the individual values of all layers in the

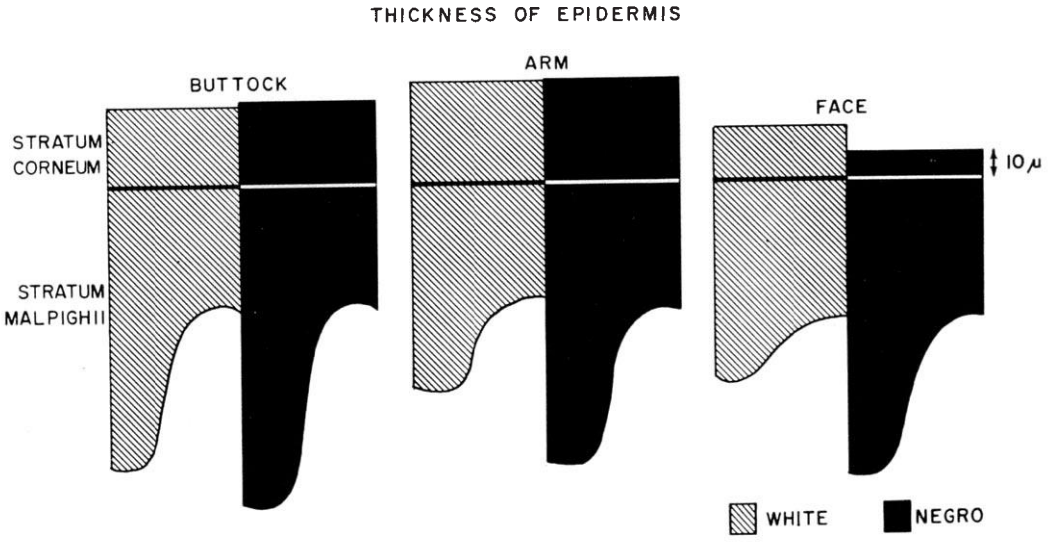

FIG. 1

severely damaged group. However, none of the average value differences in this comparison were of statistical significance.

DISCUSSION

The association of sunlight and skin cancer has been the subject for many observations and experiments concerning the action of the active ultraviolet wavelengths on the skin. Paradoxically, few changes other than overt carcinogenesis have been described in the epidermis as being due to sun or ultraviolet exposure while a great deal of work has dealt with the dermal changes under such conditions, even though the epithelium is the structure which ultimately gives rise to the skin cancer. This is perhaps because the early dermal changes are more evident and striking than the epidermal changes. With the usual histological methods very few epidermal alterations are visible until late when premalignant or malignant transformation has already taken place. Changes in the appendages with increasing age were not striking on careful inspection; however, a more detailed evaluation of the appendages is planned using all the various special stains available.

In the present study an attempt was made to evaluate the influence of sunlight exposure as well as race, age, sex, and complexion on epidermal thickness alone without regard for qualitative changes in the epidermis. The racial and regional differences were especially interesting in that they suggest that the skin reacts to sunlight exposure by flattening of rete ridges while the suprapapillary minimal thickness of epidermis remains constant. Protection of the skin by clothing or high melanin content appears to prevent these changes. The possibility of purely regional or racial variation was also considered. This study did not yield information indicating whether these changes were due to direct action of absorbed energy on epidermal cells or were secondary to dermal damages. However, epidermal thinning occurred before any dermal changes could be detected microscopically.

The method of measurement used here yielded consistent results on repeated trials of measurement on the same specimens. The thicknesses recorded, of course, represent the values for the fixed stained microscopic section which has inevitably undergone some shrinkage and distortion during processing. These values are not presented as absolute dimensions for living human epidermis. However, all the preparations were performed under as near identical conditions as possible by one technician, using identical solutions, procedures, etc., and the use of these values for comparative purposes based on a statistical analysis seems justified.

SUMMARY

Measurements of epidermal thickness in 28 human volunteers reveals shortening of rete ridges in exposed white skin, and this was not seen in unexposed skin nor in Negroes.

Differences in epidermal thickness related to age, sex, complexion, or variation in sunlight exposure were not statistically significant.

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